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ABSTRACT

A conceptual basis for a major study on science education in Canada to be conducted by the Science Council of Canada is presented. Section one explains the rationale behind the study. Different people argue that the relevance of science to daily living has been lost and that science education should therefore focus on the purpose of science rather than the content. This section also lists the three major aims of the study: (1) to establish a documented basis for describing the present purposes and general characteristics of science teaching in Canadian schools; (2) to conduct an historical analysis of science education in Canada; and (3) to stimulate active deliberation concerning future options for science education in Canada. Section two, the focus of the study, discusses the target of the study (elementary and secondary education, teacher education), dimensions of science education (begin with physical and biological sciences), and evidence of educational purposes (aims, goals, objectives, programs, textbooks, class events). The final section describes the procedures of the study as deliberate inquiry based upon political realities and identifies three phases: issue identification, data collection, and option development. (DC)

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THE BASIS FOR A RESEARCH STUDY

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Graham W.F. Orpwood

Science Council of Canada

May 1980

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Preface

In reading this description of the basis of a Science Council study of Canadian science education, the reader may find it helpful to recognize three distinct "languages" or levels of discourse with which the study will be involved.*

At one level, there is the language of science itself, the language of chemistry, physics, and biology. This is also therefore the language of the science textbook and science classroom, and it is this language that students are expected to acquire in the course of their science education.

At another level, there is talk about science teaching. Here, the language of pedagogy enables discussion about aims and objectives, about alternative strategies for instruction and evaluations, and about the ultimate purposes of education for students. The language is thus common to teachers of a variety of disciplines, unlike the languages of the disciplines they teach. Also, the language of pedagogy is prescriptive or normative in tone, unlike the language of science. It is therefore the language in which various "positions" concerning what, say, science education in schools ought to be doing. And, in this respect, it is a language shared by many people both inside and outside school systems.

However, to conceptualize and explain this prescriptive level of discourse, it is necessary to employ yet a third level of language, called here "the language of curriculum inquiry." This is as different from the language of pedagogy as the latter is from that of science. And since the substance of the planned study is concerned with pedagogical matters--why students should learn science, for example--the study itself must be conceptualised and described in the language of curriculum inquiry.

Accordingly, this paper does not join discussion at the level of pedagogy arguing, for example, for this or that set of goals for science education, but at the "meta-level" of curriculum inquiry. Here the major concern is for the planning of a study that is both appropriate to the nature of the enterprise under investigation, and also in accordance with the mandated responsibilities of the Science Council of Canada.

* This is adapted from: F. Michael Connelly and Douglas A. Roberts, "What Curriculum for Graduate Instruction in Curriculum?", Curriculum Theory Network, 1976, Vol. 5, No. 3, p. 186.

Introduction

At its October 1979 meeting in Fredericton, N.B., the Science Council of Canada approved a major study on Canadian Science Education.* This decision followed a series of Council discussions of the subject focussing chiefly on a discussion paper prepared by James Page, entitled "A Canadian Context for Science Education", and on the Report of a Working Group on Canadian Science Education. As a result of these discussions, Council concluded that the establishment of a study on science education in Canada could be justified as important to the scientific health of the nation, and thus as falling within its mandated responsibilities.

In what follows, a conceptual basis for this study is set out. The substantive focus that is planned for the study is approached indirectly by way of a brief outline of the reasons for conducting such a study at this time, and a final section contains an account of the procedures and methods to be employed. A summary statement of the planned research programme is attached in the form of an appendix.

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* A definition of what is to be regarded as "Canadian Science Education" for the purposes of the study is set out later in the proposal.

RATIONALE FOR THE STUDY

Reflections on Criticisms of Science Education

In the past few years, a new wave of criticisms of science education has been emerging. Of itself, criticism of education is nothing new; education has perennially been the target for many types of diverse critical comment originating both outside and inside the formal educational enterprise. But from time to time, criticisms of a particular type seem to come together to generate an especially strong challenge for change. The history of education contains many such examples; in the case of science education, the post-Sputnik move toward a greater emphasis on the nature of science is one such instance. But the present wave is quite different from that one. At issue now is not that students are not learning what "science" is, nor that they are failing to learn enough of it (although this is a continuing matter of concern to some critics), but rather that they do not come to appreciate its personal, social, or national relevance.

There is not space here to catalogue all of the criticisms that constitute this wave, not even all of those from within Canada. A few, however, can be taken as representative.* Professor Symons, in the

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* Several of the citations in this section have been drawn from the (unpublished) Report of the Working Group on Canadian Science Education, prepared for Science Council Discussion in October 1979.

Report of the Commission on Canadian Studies, makes a number of observations about science education and these have been collected and analysed by James Page in a Council Discussion Paper, "A Canadian Context for Science Education." Typical of these observations is the following:

> Canadian school children learn of the accomplishments and impact of science in other countries...but they learn virtually nothing about the impact of science in their own country. And the reason is that they are not being taught such matters.[1]

David Suzuki also has expressed concern both for the adequacy of contemporary science education to "prepare (young scientists) to shoulder any responsibility to society"[2] and also for whether it enables citizens and politicians "to deal with the many problems we face today for which there is an underlying scientific basis."[3] Still other critics have sensed that the public feels alienated from the world of science and technology; such critics see science education in schools, if not as actively contributing to these feelings of alienation, then certainly not as responding positively to them.

Nor are such criticisms confined to Canadian science education. Fletcher Watson, a distinguished American science educator formerly of Harvard University, has claimed that the "swing from science" by

students in the United States is evidence "that our present curricula in science are inconsistent with public concerns",[4] and he identifies these public "concerns" with areas of public decision making involving the applications of science and technology. Parallel criticisms are also implicit in a recent discussion paper of the (British) Association for Science Education.[5] This selection represents only the highlights of the growing body of commentary critical of the science education enterprise as it is perceived to be operating in today's schools. It is enough, however, to warrant some reflection on the nature of the criticisms, on the particular aspects of the practice of science education which are, in effect, under attack, and on why these aspects are being criticised at this particular time. This reflection can enable a clearer vision of appropriate aims for a Science Council study.

First, however, it should be noted that, for the most part, the criticisms have been formulated without specific empirical evidence. For this reason, their validity cannot be assumed in advance, and in reading much of what follows, the reader should bear this qualification in mind. Later in the paper, specific attention is given to the matter

of documenting the actual state of science education in Canada as it relates to these criticisms.

The criticisms constituting this recent wave of disquiet about science education have two important common factors. First, as has already been observed, they express concerns for the recognition in science education of the relevance of science to the everyday lives of students or, as it has been expressed elsewhere, for the adoption of a "Science-and-Society emphasis" in science education.[6] Second, in arguing for such an emphasis, the critics are focussing their attention less on the content of science education--which scientific topics should be taught and learned--and more on the purposes for which students should be taught science at all. It is not argued by this wave of criticism that students should learn more (or less) about, say, magnetism or genetics but that such topics should be learned with the intent that students recognize the social and personal relevance of such scientific knowledge. This point is a crucial one when a focus for the study is described. It is relevant at this stage since it enables one to gain a perspective on the historical significance of the criticisms presently being heard. To understand this perspective more

fully, it is useful to consider the range of factors or "determinants" that influence the selection of goals or purposes in school curricula.

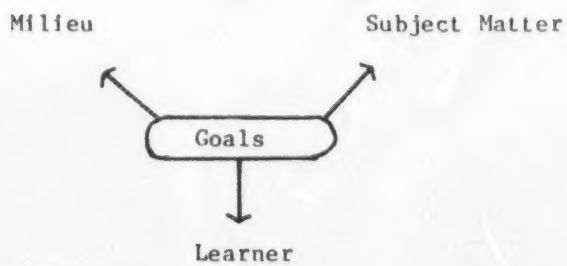
The Concept of Curriculum Determinants

Joseph Schwab, in his essay "The Teaching of Science as Enquiry",[7] describes the "grounds of curriculum decision" in terms of a list of four "clusters of curriculum determinants" or, as he calls them elsewhere, "curriculum commonplaces": the milieu (or social context), the learner, the teacher, and the subject-matter. As a heuristic framework for illuminating curriculum discussions, both in science education[8] and more generally,[9] these four have been shown to have considerable value. For present purposes, a slight modification can provide a useful, if somewhat oversimplified, perspective on the historical trends in the purposes that have been claimed for science education. If one accepts that the teacher's function as a curriculum determinant can be exercised chiefly in the process of goal selection, then the goals themselves (at any given time) may be thought of as being the result of a tension produced by three forces, corresponding to each of the other three curriculum determinants. This tension is represented diagrammatically in Figure 1.

Figure 1

Curriculum Determinants and the

Goals of Education



At any one time, the strong claims of one or more of these factors may have the effect of outweighing the claims of the others, thus "biasing" the selection in a particular direction. For example, it is well documented that, in the post-Sputnik era referred to earlier, in response to public demands for more and better trained scientists and technologists, the "subject-matter" determinant exerted an overriding force on the goals of secondary school science education.[10] At the same time, and consistent with this movement, the increasing impact of educational psychology on school practice can be cited as one reason in the increasing significance of the "learner" determinant in the goals of elementary science teaching.[11] Given these trends during the

past twenty years, one might reasonably expect that criticisms from the vantage point of the "milieu" would, sooner or later, make themselves heard.

It is interesting also to reflect on the background to this Science Council study, in the light of these "curriculum determinants". The Science Council colloquium held in 1978 with Professor Symons ensured the strong representation of one particular dimension of the "milieu", namely the Canadian studies dimension. (There are other dimensions to the "milieu" also; these are referred to in a later section of this paper.) The same dimension was reinforced in Page's "Canadian Context for Science Education" and again provided the focus for Council discussion. The significance of the heuristic device introduced in this paper is that the Symons/Page perspective can be recognized as one important perspective among many. As noted earlier, there are not only other aspects of the milieu (Suzuki's, for example), but also the milieu is only <u>one</u> determinant amongst three which together contribute to the determination of goals for science education. This point also becomes important when the substantive focus of the study is discussed. For the present, it can provide the background against which general aims for the study can be outlined.

Aims for the Study

The first aim of the study is to establish a documented basis for describing the present purposes and general characteristics of science teaching in Canadian schools. The lack of such a basis, it has already been implied, prevents much reasoned debate over the claims implicit in much of the current wave of criticism. The framework outlined here can enable an analysis of the purposes of science education in Canada which, in turn, can permit serious attention to be paid to the criticisms identified earlier.

A second planned aim is to extend the inquiry into purposes back in time to conduct an historical analysis of science education in Canada. The value of an historical perspective has already been demonstrated in the present paper. In understanding the background to present practices, it is helpful to reflect on the arguments of those who have gone before. However, very little (if any) effort has been made to document historically the purposes of science education in Canada.

The third aim follows readily from the first two. If change is not only to be justified logically but also to be effected practically, then those responsible for science education in Canada must be prepared to deliberate over their own purposes and practices. To stimulate active deliberation concerning future options for science education in Canada is therefore another aim for the Science Council study.

FOCUS OF THE STUDY

The theme of "purposes for teaching science," which is at the heart of the rationale for a Science Council study, also provides a helpful transition into a discussion of the more concrete question of what the object or focus of the study will be. At issue in this section are questions of what sectors of the education enterprise (e.g. elementary, secondary, post-secondary, adult or continuing, informal or non-institutional, etc.) will be the target of the study, what areas within those sectors will be considered as "science" education (as distinct from other academic areas) and, most importantly, what concrete realities will be examined as evidence of "educational purposes", which are of their nature often hidden. The first two of these are problems of identifying points of initial emphasis, while the third requires somewhat more detailed analysis.

Educational Sectors

Science is taught and learned for a wide variety of purposes. The purposes students have for learning science change as they mature and begin to make more choices for themselves. And the stated purposes of science courses become more precisely and narrowly defined as one moves from kindergarten through the doctoral level. At the highest levels, the purposes for which science is taught and learned are relatively

well defined and specific. For the most part, the foci of such courses (and, correspondingly, of the students enrolled in them) are on careers in the sciences, or in science-related fields such as medicine or engineering. These clear purposes provide a firm basis for attending to questions or criticisms that may arise concerning the content or methods of such courses.

By contrast, science teaching in elementary schools (and, to some extent, in secondary schools also) has no such clearly established and articulated single set of purposes. That, in itself, is not a defect. It is a reflection of the nature of the schools and of their obligation to serve the needs of a much broader variety of students. Courses that make up the science curriculum thus have a broad range of purposes. For example, some students in grade nine already have a clear idea that they want to pursue a science-related career. For them, the science they learn at this level is a foundation for what will come after. Others in the same class may go on to higher education and, ultimately, to responsible positions in society but may never take another course in science in their lives. Still others may leave school and formal education at this stage and go directly into a working environment in which they handle sophisticated products of modern technology. And in addition, all of these students will be living as citizens in a society in which an understanding of the impact of science and technology is

important. It is the duty of the school to attend to the needs of all students, and thus of the science program to fulfill a wide variety of purposes. Criticisms and questions relating to school science teaching are therefore extremely difficult to deal with, since there is no clear and single basis for evaluation.

It is planned that the study will place its initial emphasis on science education in elementary and secondary schools. These are the areas on which recent criticisms have had their principal focus. They are also the areas, as pointed out here, in which such questions and criticisms are least easily resolved. University science education will be of interest in the study insofar as it relates to or affects school science education. The training of science teachers is an obvious instance. However, a study in which all areas of science education were to be examined would run the risk of being too superficial in its examination to be useful. In the interests of thoroughness, therefore, the study will focus chiefly on science teaching in schools.

The selection of school science education as the initial focus of the study raises a question about those science-educational activities which fall outside the formal school system. These would include, for example, educational radio and television, continuing or adult

education, science publishing for the general reader, museums and science centres, films, and other activities or institutions designed to promote public awareness of science. Consistent with the decision to place the initial emphasis of the study on school science education, it is planned that other educational activities be considered only as these impinge upon school science programs. There are many occasions when the informal or non-institutional forms of science education interact with school science education as, for example, when a science class visits a science centre or conservation area, or when a teacher uses a scientific film in the course of his teaching. The potential of these activities outside the school will be considered in this study in the context of examining teachers' instructional strategies. In this connection, the work of the study can be seen as bearing a close relationship to the broader and still developing area of Science Council concern relating to the public awareness of the role of science in society.

"Science" Education

The stipulation of what is to be regarded by the study as "science" education, as distinct from education in other academic disciplines, is difficult because it is necessarily rather arbitrary. It is not readily resolved by means of generating a philosophical definition of "science" and then attempting to use this definition to distinguish

among school programs. And lists of school programs contain distinctions whose significance is administrative rather than philosophical. Yet, school people do have a sense of what they regard as "science" education as distinct from other school program areas. And this would seem to be as good a starting point as any.

It is planned to allow a precise definition to emerge during the course of the study. As a starting point for the research, areas of the school curriculum usually designated as "science" (e.g. physical and biological sciences) will be the initial areas of interest. As the study proceeds, other areas may be included. For example, if the connection between science and mathematics is seen to be of major importance, then aspects of school mathematics education can be examined later in the study. There are also many other courses or programs offered by schools in various parts of the country which bear equally strong links to the physical or biological sciences. Decisions concerning such courses or programmes will be reached as the study progresses.

Evidence of Educational Purposes

The purposes people have for their activities, like other mental abstractions, are not, of course, directly observable, but must be inferred from other observations. In the case of the purposes

underlying science education in schools, two principal types of evidence would seem to be useful in achieving the overall aims of the study: statements of the intended purposes of science educators; and accounts of the activities designed to bring about the stated purposes. Each of these requires some description, in order to explain the nature of the logical links between them.

First, the purposes of science education in any jurisdiction - whether Province, school district, school, or classroom - are usually stated in the form of aims, goals, or objectives (the terminology varies). At the Provincial level, for example, these statements of purpose are most often incorporated in curriculum guidelines or policy statements, issued by the Provincial Minister of Education. At other levels of the school system, more detailed aims and objectives are progressively specified right to the level of an individual teacher's lesson plan. The same policy documents also outline, to some degree at least, the science content of school programs and this too becomes more finely specified by successive policy documents or courses of study, developed at the local level. A detailed analysis of such documents can reveal both what students are intended to learn in science programs, and also the intended purposes for which they learn science at all.

From the national perspective of the Science Council study, it is planned that all Provincial documents relating to science programs be so examined, together with examples of documents drawn from other levels of school systems. Corresponding information will also be sought from numbers of individual teachers.

Of equal importance to the study is the need to gather information concerning the ways in which the stated goals are realised in school programs, textbooks, and classroom events. The importance of this planned focus for the study rests on a notion of "teaching" as being the provision of appropriate experiences from which students may learn (where "appropriate" is defined in logical rather than psychological terms). Such a notion has distinguished academic roots in such works as Dewey's Experience and Education.[12] It has been articulated, more recently, by Komisar,[13] Hirst,[14] and by Roberts and Silva, who write as follows about "effective teaching."

> We find it helpful...to think of "effective teaching" in terms which are more nearly analytical than empirical. That is, there are times and circumstances when it is "effective" to perform certain highly specific intellectual acts (e.g. demonstrating where a model does or does not account for data). One needs

> no empirical studies of the reactions of students, the personality characteristics of teachers, or the inter-observer reliability of a rating scale to decide whether provision is being made for the students to "get the point" of the teaching act.[15]

A simple illustration can serve to relate this notion of teaching to the concern of the study with the purposes of science education. If it is a teacher's stated purpose to have his students develop the skill of, say, hypothesizing, and if his teaching contains no opportunities for the students actually to develop hypotheses, then on logical grounds one can say that the teaching has failed to make provisions for that purpose. Similarly, if it is the teacher's intention that students understand how societal choices involving scientific knowledge are made, then the students must both experience such choices (directly or indirectly) and also have those experiences interpreted for them.

The consequence of this notion in the present context is that, by the examination of textbooks, curriculum guides, and samples of actual classroom events, (especially if supplemented with teacher interviews), an assessment can be made of the extent to which the purposes stated for teaching science are being provided for in practice. One component

of this part of the study could comprise an assessment of the actual use and potential consequences of a range of educational technology including computers, television, programmed courseware etc. Another could include an assessment of the adequacy of the facilities required for implementing alternative educational goals. For example, one of the considerations to be addressed in discussing the appropriateness of goals in the "science-and-society" area must be the provisions required for their realisation. The notion of teaching outlined here provides a clear basis for such discussion.

It should be noted that the "assessment" described here is an objective inquiry into the congruence between stated and realised purposes. The normative question of the worthwhileness of either set of purposes is a matter for consideration in the context of deliberations, described later in the paper.

PROCEDURES OF THE STUDY

To this point, the paper has stated a rationale for the Science Council's engaging in a study of Canadian science education at this particular time and has outlined certain target areas that the study will focus on. In setting out these plans, the paper has strenuously avoided making *a priori* assumptions about the very realities which the study will examine. (The criticisms referred to at the outset, for example, are taken, at this stage, to be assertions for which the evidence is still largely absent.) Nevertheless, in charting strategies for the study, it is necessary and important to recognize some of the more general characteristics of the enterprise on which the study is to focus.

Political Realities

Matters concerning the goals or purposes of science education are political matters in two important ways. First, they are political because, constitutionally, education in Canada generally falls within Provincial jurisdiction. The complete authority for making educational decisions thus rests with Provincial (and Territorial) governments and (as delegated by them) with local boards of education. Since, for practical purposes most boards of education delegate some areas of decision, particularly with respect to teaching methods, to the

professional judgement of teachers, the actual "authority" for the teaching of science is distributed extremely broadly through several levels of political and professional responsibility. Agencies such as the Science Council of Canada, having no formal role within this hierarchy, can neither demand nor assume the attention or cooperation of any of the institutions and individuals involved. Such attention and cooperation can only be invited, and may be volunteered only under certain conditions. With it, the potential of the study to meet its goals is good; without it, the Science Council will effectively be unable to conduct a study at all. Such is the first political reality of science education.

The second political reality is of a different order from the first and represents a different sense of the term "political". The fact of Provincial responsibility for education can be regarded as political in a technical sense. The problem of selecting educational goals is also political, but in a more philosophical sense. In outlining an illustration of a fundamentally political problem, Aristotle cited the case of what we would call the aims and objectives of the public school curriculum as the paradigmatic example.

> That education should be regulated by law and should be an affair of state is not to be denied, but what

> should be the character of this public education, and how young persons should be educated, are questions which remain to be considered. As things are, there is disagreement about the subjects. For mankind are by no means agreed about the things to be taught, whether we look to virtue or the best life. Neither is it clear whether education is more concerned with intellectual or moral virtue. The existing practice is perplexing; no one knows on what principle we should proceed--should the useful in life, or should virtue, or should the higher knowledge be the aim of our training; all three options have been entertained.[16]

In contemporary terms, one can say that, in reaching decisions concerning educational goals, educators must necessarily select from among alternative options, each of which may be equally legitimate in principle. The final selection is not "right" in that others are "wrong"; it is only (ideally) the best, given present desires and present circumstances. Decisions made twenty years ago, for example, (and present practices which derive from those decisions) are not necessarily "wrong" in the sense that people should have decided

otherwise. They may, however, require review in the present light of contemporary values and a new situation.

Deliberative Inquiry[17]

From these two political facts of life flow a series of consequences, important to planning the procedures for this study. First of all, the general strategy of the study is designed to be appropriate to the political nature of the selection process outlined above. It cannot therefore be simply a method of deduction from principle nor one of induction from data, but rather one of deliberative inquiry stimulated and coordinated by the Science Council but engaged in by those having responsibilities for science education throughout Canada.

The reasons for planning such a strategy are simple ones. First, the ultimate product of the study is not to be found in a document in which reasoned arguments and carefully researched evidence are put together (though such reports undoubtedly will be generated). The ultimate product of the study must be looked for in the science classrooms across the country, for it is only there that change has real significance. Second, the right to decide on actions within these science classrooms rests, as has been noted here, with political and professional groups outside the direct influence of the Science

Council. Third, since the Science Council's goal is to contribute to the improvement of existing science education institutions, rather than their radical overthrow or replacement, then it must endeavour to conduct a study in cooperation with the practitioners rather than in spite of them. And practitioners have little time for theoretical or abstract debate about the "state of affairs" unless there is also a real prospect of practical deliberation about their own goals and activities. Thus, a deliberative inquiry would seem to be both appropriate and necessary, if the study is to have significant impact.

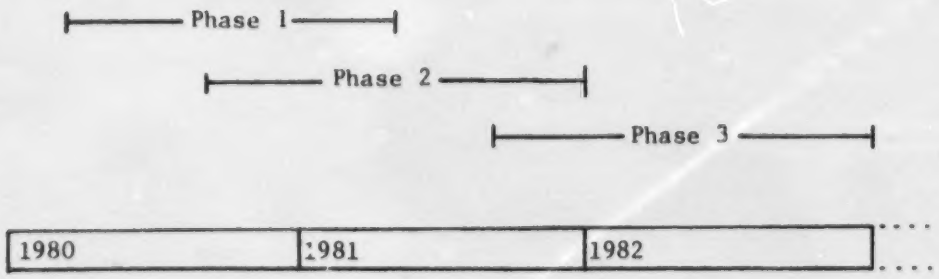
Such deliberative inquiry requires three major components: a continuing commitment to deliberation on the part of all those involved; a reliable knowledge base about the enterprise on which deliberation is to focus; and a range of issues and alternative courses of action which can form the substance of deliberation. It is expected that the development of these components will be the central task of the study. Since they are inevitably interrelated, all three components require, to some extent at least, simultaneous attention. However, at any given time, it is likely that one component will occupy the attention of the study more than the others. For this reason, it is possible to consider the study in terms of three over-lapping phases, occupying a total of three years (from February 1980 until December 1982) as follows (dates are approximate):

1. Issue Identification (Feb. 1980 - March 1981)
2. Data Collection (Sept. 1980 - Dec. 1981)
3. Option Development (Sept. 1981 - Dec. 1982)

The chronological relationship among these phases is shown in Figure 2.

Figure 2

Planned Schedule For The Study



Each of these phases is next discussed briefly.

The first phase, issue identification, has already begun with the publication of Page's discussion paper "A Canadian Context for Science Education." It is intended to commission a series of such critical discussion papers each presenting from a distinct perspective a view on the goals of science education. In this context, Page's paper can be regarded as arguing that science education should pay greater attention

to goals in the area of Canadian Studies. It will be recalled that the range of possible perspectives was described earlier in the paper in terms of three curriculum determinants or commonplaces, the learner, the subject matter, and the milieu, and that the perspective adopted in Page's paper was identified with the milieu. Some papers planned for this series will speak for other dimensions of the milieu, while others will take the perspectives of the learner and of the subject-matter. All will be critical in tone, since they will attempt to challenge science educators to reflect on their current policies and practices with a view to deliberating about alternatives for the future. These papers are thus intended to have a dual function. They are intended to stimulate the commitment of those responsible for science education to deliberation; they are also intended to provide an initial (but not exclusive) agenda of issues for deliberation. As the inquiry proceeds, the agenda for deliberation must be fluid enough that additional issues can emerge and that priorities among issues can develop. At the same time, it will be the responsibility of the study to ensure that legitimate issues do not disappear by default (i.e. without conscious decision). This phase is necessarily a lengthy one, because of the time required to generate and disseminate discussion papers.

Before the process of issue identification is complete, the phase of data collection can begin. Much of this involves the collection and

analysis of policy documents and of statistical information required to develop a clear picture of the present and past situation, with respect to science education policies and practices. Other parts of the data collection phase will consist of the detailed study of instances of science teaching from around the country. It is anticipated that such work will largely be contracted out to researchers in all parts of the country. This phase will also include the collection of special data, again possibly through contracted-out projects, relevant to the particular issues identified in phase 1. For example, if the issues raised by Page's paper continue to be important ones as the study progresses, then the extent to which the history of Canadian scientific inquiry is reflected in courses of study across Canada could become an important empirical question requiring detailed investigation.

The final phase will involve the generation and consideration of options for the future. In this connection, it is useful to consider the anticipated location and composition of deliberations. First, as regards location, decisions about science education take place all across the country at Provincial, board, and teacher levels. It is therefore appropriate to recognize that the ultimately definitive deliberations must be at these levels (rather than, say, in Ottawa). However, since the Science Council is limited both in resources and in

time, it is intended that this part of the study be conducted through Provincial (or regional) conferences and workshops and that persons within those areas be encouraged to stimulate more local deliberations also. Science Council staff could become involved in local situations to develop models for such deliberations. It is possible that a National Conference could also be of general value, while not replacing the specific deliberations within Provincial jurisdictions.

Concerning the composition of deliberations, Schwab's four commonplaces again provide a checklist of "bodies of experience" among which a balance is desirable.[18] Clearly, those professionally responsible for science education need to be present (the "teacher" commonplace). Also important are those who can represent knowledge and experience of the learner such as psychologists and sociologists but also including parents, social workers, and school guidance personnel. The subject matter must be represented, in this case, by the scientific community and by philosophers and historians of science. Finally, "the milieu" provides the basis for others to participate who, while not having formal responsibility for school education, nevertheless have a stake in its outcome. These can include representatives of industry, agriculture, medicine, government, etc. These lists are not exhaustive but they suggest, in an ideal way, the variety of participants which deliberations might involve. In practice, some individuals may

represent a variety of bodies of knowledge and experience. The final and most essential role in deliberations must be that of a chairman who can comprehend the complexity of the process and regulate its conduct. It should be the responsibility of the project staff to ensure, as far as is possible, that a balance of these bodies of experience are represented at Council sponsored deliberations.

A variety of products of the study can be expected to be developed by these procedures. First, it is anticipated that a large amount of useful information will be gathered during all phases of the inquiry and that this might be collected and published by Council. Second, the proceedings of some of the deliberations sponsored by the study may be considered to be worth publishing as models of such deliberation. Third, Council may choose to take a position itself on the purposes for science education and publish such a position in the form of a formal report. Finally, when the formal study sponsored by the Science Council is concluded, it is hoped that the deliberations over policies and practices stimulated through the work of the study will have the momentum to continue.

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STUDY OF CANADIAN SCIENCE EDUCATION

SUMMARY OF RESEARCH PLANS

In a society whose dependence upon science and technology is becoming progressively greater, a public having little or no understanding of the impact of science on society is one which is at the mercy of technological change rather than in control of it. Recent criticisms of science education in Canada can be interpreted as suggesting that school science programs are failing to provide students with an appreciation of the personal, social, and national relevance of science. If these assertions are correct, then the consequences both for Canada and Canadians are serious ones. At issue here, for science education, is not so much what science is taught or learned, but rather the purposes for which science is taught in schools, and the probable consequences for students of teaching science in alternative ways.

In recognition of the plausibility of these concerns, the Science Council of Canada has authorised a major study into science education in Canada, and the following aims, focus, and procedures are planned for this study.

Aims:

1. To establish a documented basis for describing the present purposes and general characteristics of science teaching in Canadian schools.

2. To conduct an historical analysis of science education in Canada.

3. To stimulate active deliberation concerning future options for science education in Canada.

Focus:

1. The initial emphasis of the study is to be placed on science programs in elementary and secondary schools.

2. The study is to be focussed on science programs provided by formal educational institutions (i.e. schools) with attention given to other, informal, educational activities only as these impinge upon school science programs.

3. For the initial purposes of the study, "science" is to be taken to refer to those areas of the school curriculum designated as "science" (e.g. physics, chemistry, biology, etc.).

4. Two forms of evidence of educational purposes will be examined: (a) evidence of intended purpose (e.g. as outlined in Provincial curriculum documents);
(b) evidence of operational purpose (e.g. as inferred from classrooms and textbooks).

Procedures: The overall strategy will be one of "deliberative inquiry" involving three major components:

1. The stimulation and maintenance of a continuing commitment to deliberation (both by practitioners and by others having a stake in Canadian science education).

2. The development of a reliable knowledge base about Canadian science education (to inform deliberation).

3. The generation of a range of issues and alternative courses of action (to form the substance of deliberation).

ÉTUDE SUR L'ENSEIGNEMENT DES SCIENCES AU CANADA

ESQUISSE DU PLAN DE RECHERCHE

Comme la société est de plus en plus tributaire de l'effort scientifique et technique, il faut que le public comprenne bien ses répercussions dans la collectivité; ainsi pourra-t-on en orienter les progrès de façon favorable. Les critiques formulées récemment à l'endroit de l'enseignement des sciences au Canada suggèrent que les programmes scolaires ne permettent pas aux élèves d'apprécier l'intérêt des sciences pour l'individu, la collectivité et le pays en général. Si ces critiques étaient bien fondées, cette lacune aurait des conséquences graves pour le Canada et ses citoyens. Il convient de s'interroger non pas tant sur le contenu des cours de sciences que sur les finalités de l'enseignement scientifique et sur les effets probables des différentes méthodes pédagogiques employées.

Conscient de la légitimité de ces préoccupations, le Conseil des sciences du Canada a décidé la réalisation d'une importante étude sur l'enseignement des sciences au Canada; voici quels en seront les centres d'intérêt et les objectifs, de même que la méthode employée.

Objectifs de l'étude:

1. Elle permettra de réunir une base de données pour délimiter les finalités actuelles et décrire les caractéristiques générales de l'enseignement des sciences dans les établissements scolaires canadiens.

2. Elle aidera à analyser l'historique de l'enseignement des sciences au Canada.

3. Elle suscitera de sérieuses réflexions sur les orientations possibles de l'enseignement des sciences au Canada.

Centres d'intérêt:

1. L'Étude portera essentiellement, dès l'abord, sur les programmes d'enseignement des sciences dans les écoles primaires et secondaires.

2. Elle sera axée sur les programmes de sciences dispensés par les établissements reconnus, c'est-à-dire les écoles, les autres activités pédagogiques para ou extrascolaires n'étant examinées qu'en fonction de ces programmes.

3. Précisons qu'aux fins de l'étude, nous entendons par "sciences" les matières enseignées traditionnellement sous cette rubrique: physique, chimie, biologie, etc.

4. Le groupe de recherche étudiera deux manifestations des finalités pédagogiques:
a) les objectifs visés (définis dans les programmes scolaires élaborés par les autorités chargées de l'enseignement);
b) les objectifs pratiques (se dégageant de l'enseignement magistral et des manuels).

Stratégie: Elle consistera en une investigation dialoguée, comprenant trois volets distincts.

1. Un effort constant de réflexion collective, tant parmi les enseignants que chez les autres responsables de l'enseignement des sciences au Canada;

2. Le rassemblement d'une base de données utiles sur l'enseignement des sciences au Canada, qui servira à alimenter la réflexion;

3. La mise en relief d'une série de questions à débattre et des diverses options éventuelles, qui constitueront le thème de la réflexion collective.